APPENDIX

What is Claimed:

2. The drilling tool assembly as defined in claim 16 further including means for rotating said bent portion to a predetermined position.

3. The drilling tool assembly as defined in claim 16, wherein said clutch mechanism is a mechanical clutch which transmits torque using physical contact of surfaces.

4. The system as defined in claim 16, further including a means for transmitting information describing the clock face position of said rotatable housing.

5. The system as defined in claim 16 further including a steering guidance system means within said rotatable housing.

16. A drilling tool assembly comprising:

a steering system,

a drilling motor,

an orienter and ,

a drill bit,

wherein said drilling motor includes a motor output shaft which provides output power to said drill bit;

wherein said orienter includes a first non-rotatable housing and a second rotable housing;

wherein said first non-rotatable housing surrounds a clutch mechanism and a speed reduction system;

wherein said clutch mechanism transmits rotary power from said motor output shaft to said speed reduction system, said speed reduction system located between said clutch mechanism and said second rotatable housing;

wherein said second rotatable housing includes a flexible coupling connecting said motor output shaft to an orienter drive shaft which is connected to said drill bit;

wherein said second rotatable housing further includes a bent portion surrounding said orienter drive shaft;

whereby when said clutch mechanism is actuated, rotary power from said motor output shaft is transmitted through said clutch mechanism, through said speed reduction system to rotate said second rotatable housing, while said orienter drive shaft continues to rotate said drill bit.

17. The drilling assembly as defined in claim 16 wherein;

said drilling tool assembly is constructed and arranged for mounting to the end of a length of coil tubing.

18. A method of directional drilling using the assembly of claim 16.

DESCRIPTION OF THE EMBODIMENTS

[0023] The orienter **10** of the present invention is attached to the drilling motor assembly **20** portion of a drilling tool assembly **100**. The motor assembly **20** portion is used primarily for turning a rotating drill bit **130**. By repositioning the orienter assembly **10** of the present invention to a different location within the drilling tool assembly **100** than is found in prior art drilling tool assemblies, the construction of the drilling tool assembly is simplified and its overall length is reduced. This simplified construction and reduced length makes a drilling tool assembly **100** incorporating the orienter **10** of the present invention easier to use by eliminating the logistical issues and special job site planning considerations associated with more complex, longer length prior art drilling tool assemblies.

[0024] As may be seen in Figure 1, the orienter **10** of the present invention is used in a drilling tool assembly **100** which is mounted on the end **115** of a length of coiled tubing **110**. The coiled tubing **110** is typically stored on a mobile platform **200** at the earth's surface. An injector assembly **140** connected to the mobile platform **200** grasps the coiled tubing **110** and exerts linear force thereon to move it through a subterranean borehole.

[0025] As may be seen in Figure 2, the disclosed orienter **10** forms a part of a drilling tool assembly **100**. The drilling tool assembly **100** is designed and provided with the necessary hardware well known to those of ordinary skill in the art for mounting on the end of coiled tubing **110**. Beginning at the end **115** of the coiled

tubing **110** which connects to the drilling tool assembly **100**, the drilling tool assembly **100** includes a steering tool assembly **120** for monitoring and tracking position of the drilling tool assembly **100** in the borehole **B** as it is being drilled. Mounted next to the steering tool assembly **120** is the drilling motor or mud motor assembly **20**. The drilling motor or mud motor assembly **20** is a hydraulic motor which produces rotational power or torque from the flow of drilling fluid or drilling mud through fluid flow passages within the motor assembly **20**. It is typically the motor assembly **20** which adds the greatest amount of length to the drilling tool assembly **100**.

[0026] According to the present invention, the orienter assembly **10** of the present invention is positioned in front of the drilling motor assembly **20**, just behind the rotating drill bit **130**. The orienter assembly **10** includes a housing **30** which may be divided into an upper section **32** and a lower rotatable section **34**. Finally, at the distal end **102** of the drilling tool assembly **100** is the rotating drill bit **130**. It is the rotating drill bit **130** which actually cuts through the soils and the rock to form the subterranean borehole **B**. Linear force transmitted to the drilling tool assembly **100** by the force placed on the coiled tubing **110** by the injector assembly **140**. The linear force moves the rotating drill bit **130** forward as the rotating drill bit **130** cuts through the soil and rock at the drill face at the end of the borehole.

[0027] In Figure 2 the lower rotatable section **34** is held fast; that is, it does not rotate. Accordingly, the fixed bend **36** in the lower rotatable section **34** of the orienter **10** causes the rotating drill bit **130** to form an arcuate segment of the borehole B. As shown in exaggerated manner in Figure 2, if the fixed bend **36** is in a substantially

vertical plane, the drilling tool assembly **100** will form an arcuate segment of the borehole **B** which tracks upwardly to the earth's surface **S**, thereby allowing for removal of the drilling tool assembly **100** from the end **115** of the coiled tubing **110** after the drilling tool assembly **100** exits the borehole.

[0028] In contrast, the lower rotatable section **34**, shown in Figure 3 is not held fast or in a fixed position; instead it is allowed to turn. The turning of the lower rotatable section **34** , to include both the fixed bend **36**, and the lower portion **34**, with respect to the non-rotary housing **22** around the drilling motor **20**, enables the rotating drill bit **130** to cut a straight line segment of a large borehole. The transfer of torque from the drive shaft **24** portion of the drilling motor assembly **20** to the upper section **32** causes the entire lower rotatable section **34** to turn as shown in Figure 3.

[0029] In a macro sense, the housing **30** of the disclosed orienter **10** looks like an extension of the non-rotating housing **22** which surrounds the drill motor **20**. However, housing **30** of the orienter **10** is separate from housing **22**. This separation allows the external, lower rotatable section **34** with a fixed bend **36** to rotate constantly at a minimal rpm while the drill motor assembly **20** causes the rotating drill bit **130** to move straight ahead with an oscillating action and thereby form a straight segment of the borehole **B**, as shown in Figure 3. Disengagement of the mechanical connection between the upper section **32** from the drive shaft **24** portion of the drill motor assembly **20** and the indexing of the lower rotatable section **34** to the desired clock face position has the effect of placing the rotating drill bit **130** in a directional or

steering mode as shown in Figure 2 because the fixed bend **36** in the external, lower rotatable section **34** does not rotate. However, because the drive shaft **24** of the drilling motor **20** is still connected to the rotating drill bit **130** by a universal joint or flexible coupling **26**, and thusly, the orienter drive shaft **27**, the rotating drill bit continues to turn.

[0030] As shown in Figure 4, the necessary drive force or rotational torque which causes the external, lower rotatable section **34** with a fixed bend **36** to turn is obtained from the drive shaft **24** of the drill motor assembly **20**. In the preferred embodiment, connection of the external, lower rotatable section **34** with a fixed bend **36** to the drive shaft **24** of the drill motor **20** is accomplished by the use of a mechanical clutch mechanism **40**.

[0031] The clutch mechanism **40** may be activated by a variety of different means to include an electrical, hydraulic, or mechanical signal. In the illustrated embodiment, the mechanical clutch mechanism **40** includes a first rotating tapered or wedge section **42** with an internal contact surface **44** which frictionally engages a second rotating tapered or wedge section **46** with an external contact surface **48**. The frictional contact between internal surface **44** and the external contact surface **48** is sufficient to transmit rotational torque from the drive shaft **24** to the internal gear assembly **60**. Those of ordinary skill in the art will understand that other types of mechanical clutch mechanisms or non-mechanical clutch mechanisms may be used without departing from the present invention. Such other clutch mechanisms may include electrical clutches and hydraulic clutches.

[0032] In the preferred embodiment, an internal gear assembly **60** within the upper section **32** is used. The internal gear assembly **60** includes a plurality of externally toothed spur gears **62**. The rotation of the spur gears **62** causes rotation of the external housing **30** by engagement of a large-internally toothed ring gear **64** with the rotating spur gears **62**. The gear ratio between the spur gears **62** and the ring gear **64** provides for a reduction in speed and an increase in torque. The end result is a circular movement of the lower rotatable section **34** including the fixed bend **36** and the rotating drill bit **130** to drill a straight borehole through soil and rocks. Those of ordinary skill in the art will understand that while a simple speed reduction gear train has been shown in the preferred embodiment, other speed reducing or torque mechanisms may be used without departing from the scope of the invention, to include but not limited to a hydraulic drive or a helical actuator.

[0033] To assure proper clock face position of the lower rotatable section **34** with respect to the non-rotating housing **22** surrounding the motor assembly **20** or torque transfer, a set of radially spaced contact points or similar radial position indicating systems, well known to those of ordinary skill in the art, may be used to provide a signal representative of the clock position of the lower rotatable section **34**. As the lower rotatable section **34** is selectively rotated or indexed to a desired orientation by the motor **20**, a single contact closes a circuit at a location representative of the clock face position of the lower rotatable section **34**. The signal is received at the surface using a wireless transmission or a wire line. Knowledge of the clock face position of the lower rotatable section **34** enables the operator to assure that the fixed

bend portion **36** of the orienter **10** is properly rotated or indexed to the desired orientation to create an arcuate segment of the borehole B which follows along a predetermined path.

Operation

[0034] A still better understanding of the orienter of the present invention may be had by an understanding of its method of operation.

[0035] The system and method of the present invention is part of a drilling tool assembly **100** which typically governs the operation and direction of a rotating drill bit **130**. As distinguished from prior art orienters, the orienter **10** is positioned next to the rotating drill bit **130**. The combination of the drill bit **130**, the orienter **10**, and the mud motor assembly **20** is located on the end **115** of coiled tubing **110**. Because the orienter **10** has been relocated to a position next to the rotating drill bit **130**, it is now in a position where it can use the torque output of the mud motor assembly **20** rather than rely on a separate source of torque or rotary power. Those of ordinary skill in the art will also understand that while the conventional location for the steering tool assembly **120** which provides an indication of tool **100** location behind the motor assembly may be used, a steering tool assembly **150** may also be located inside of the lower rotatable section **34** or ahead of the mud motor assembly **20** as shown in Figure 5

[0036] The orienter **10** of the present invention may be used with it own indicators to provide position information if necessary or desired. Specifically, the disclosed orienter **10** will be capable of including a radio beacon transmitter **50** for

wireless or wireline reporting of the position and orientation of the lower rotatable section **34**.

[0037] Also, as previously indicated, the disclosed system and method allows for the orienter **10** to be placed ahead of or in front of the mud motor assembly **20**. This arrangement simplifies construction and provides easier set up of drilling operations. In addition, this configuration enables the torque provided by the drilling motor **20** to both rotate the lower rotatable section <u>34</u> including the fixed bend **36** for either drilling a straight line portion of the borehole **B** or for rotating the housing to a desired clock face position for drilling an arcuate portion of the borehole **B**.

[0038] The preferred embodiment of the orienter **10** includes the use of a gear reduction system **60** driven by the output driveshaft **24** of the mud motor assembly **20** to both change the rotary speed and torque provided. The output driveshaft **24** of the mud motor assembly **20**, when engaged with the housing **30**, rotates the lower rotatable section **34** that contains the fixed bend **36**. When desired, the gear reduction system **60** is disengaged from the output driveshaft **24** of the mud motor assembly **20** to cause the rotating drill bit **130** to create an arcuate borehole in a predetermined direction. The gear reduction system **60** can then be re-engaged to provide continuous rotation of the lower rotatable section **34**, thereby facilitating drilling a straight segment of the borehole as shown in Figure 3.

[0039] Observers of the entire system will see a large storage and spooling reel **108** containing a sufficient length of a continuous coiled tubing **110** to be injected and

retracted from the borehole as shown in Figure 1. The coiled tubing **110** is coupled to the storage and spooling reel **108**. The spooling reel **108** contains a fluid swivel at its center portion to allow fluids to be pumped through the coiled tubing **110**. An electrical wire, for communication of an electrical control signal or providing electrical power, may be inserted through the entire length of the coiled tubing **110** to provide access at the storage and spooling reel **108** for coupling to controls at the earth's surface using an electric swivel. The coiled tubing **110** is injected and retracted (pushed/pulled) by an injector assembly **140** that grasps the coiled tubing **110** and moves it in the desired direction.

[0040] The housing **22** containing the drill motor **20** itself does not contain a fixed bend section. Specifically, the drill motor assembly **20** is a straight mud motor known as a positive displacement motor or "monyo" style motor. The drill motor housing **22** abuts the leading end **115** of the coiled tubing **110** and is held in place by the coiled tubing **110** which resists the torque and tensile forces involved in the drilling process.

[0041] Typically, control of the orienter **10** requires communication of an electrical signal. This communication and any power required to actuate the clutch mechanism may be provided by an electrical wireline connection and pathway provided within the entire system. This pathway may either be fully inside the coiled tubing **110** and drilling tool assembly 100 or maintained on the outside of the coiled tubing **110** and drilling tool assembly **100**.

[0042] Alternatively, wireless means may be used for control of the operation of the orienter **10**. When a wireless control system is used, a transmitter and receiver may be used to communicate with each other, providing instructions for when to engage and disengage (rotate or go steer) the orienter **10**. Such instruction can be implemented by installing a logic assembly in the orienter **10** that receives and sends data back and forth to a transmitter/receiver that is located in the coiled tubing **110** at the leading end of the tubing **105**, above the mud motor **20**.

[0043] Once the rotating drill bit **130** exits the ground, only the orienter portion **10** of the drilling tool assembly **100** need be pushed further out of the ground. If a back reaming tool powered by the mud motor is to be pulled back through the borehole, only the orienter **10** need be removed from the front of the mud motor assembly **20** to attach the back reamer.

[0044] Critical to the operation of the orienter **10** of the present invention is the amount of torque that is generated by the speed reduction or torque conversion system. In the preferred embodiment, the torque transferred by the internal gear reduction system **60** is determined by the design parameters of the gears **62, 64**. To minimize the effect of torque on the gears **62, 64**, two functions have been incorporated into the orienter **10**. The first function is a built-in slip in the frictional power transfer engagement of the clutch mechanism **40**. This built-in slip releases the drive shaft **24** at a given amount of excess torque to prevent damage. The second function is the basic design of the housing. Although it is imperative that the housing be robust enough to withstand the forces and the conditions encountered when drilling a borehole, the

housing has also been designed to minimize the amount of resistance against the sides of the borehole to prevent a potential lag – which potential lag would be seen as increased torque load in the gear section.

[0045] While the present system and method has been disclosed according to the preferred embodiment of the invention, those of ordinary skill in the art will understand that other embodiments have also been enabled. Such other embodiments shall fall within the scope and meaning of the appended claims.